User manual for AC3D v3.4

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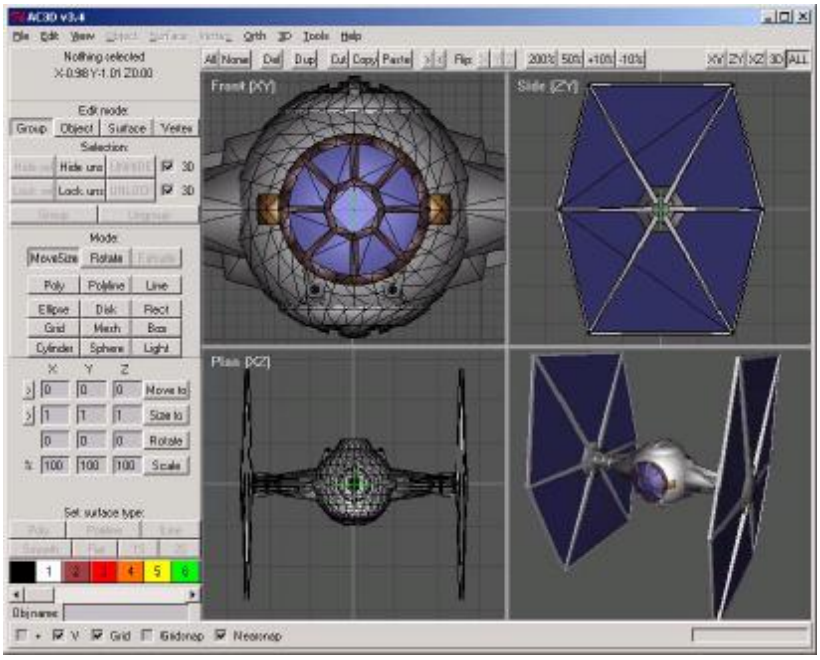
Introduction

Welcome to AC3D

AC3D is designed to make the designing and building of 3d objects fast and easy to do. AC3D is used all over the world to create 3D models for games, rendering images, and for scientific and general data visualisation.



AC3D runs on a wide range of standard hardware. You don't have to have an expensive 3D graphics card in your machine (but it certainly helps with more complicated 3D models).

AC3D is continually being developed. If you think it should be changed in any way (new features, different methods etc) then please email me. If you think there's something missing from this manual or if something could be described better then please let me know.

andy @ ac3d.org

AC3D concepts

This section introduces some of the concepts that AC3D uses to describe 3d components.

Vertex
A vertex is a single point in 3d space. It's specified by three coordinates x, y and z. More than one vertex can occupy the same position in 3d space. A vertex is always owned by a single Object, they cannot be shared between objects. A vertex is usually part of a Surface, but need not be.

Surface
A surface in AC3D is a list of vertices. Surfaces are one of three types, polygons, lines or polygon outlines. The type of a surface can be easily changed. A surface normal specifies the direction a surface is facing. Normals are used in lighting calculations. Surface normals are automatically calculated by AC3D. A surface is facing the viewer if the vertices can be seen in an anti-clockwise direction. If a surface is set to be single sided, it will only be visible from the front. Two sided surfaces will be visible from both sides. It is more efficient to draw single sided surfaces and makes more sense when used as part of an object such as a sphere (where you can't see the other side of the surfaces). Surfaces have a material attribute, which defines the color and quality (for lighting purposes). Each vertex referenced in a surface has an associated texture coordinate. Vertices can be shared between surfaces in the same object.

Object
An AC3D object is a list of vertices, and surfaces that use these vertices. It also has other attributes such as a name and texture.

Group
A group is a special object which has no surfaces or vertices buy has other objects as children. Groups are created by selecting two or more objects and pressing the 'Group button on the control panel.

Material
A material defines the colour of a surface and also the attributes that define the way it will react to light e.g. shininess.

Texture
Graphical images can be mapped onto the surfaces of an object. The images are usually from graphics files such as gif, jpg, bmp etc.

Texture coordinates
When the vertex of a surface is drawn, a texture coordinate specifies the position of a texture to map to that point. A texture coordinate is a two dimensional (u,v) value.

Bounding box
When you make a selection of objects or vertices, a green box outlines it. You can drag, resize or rotate this box to adjust the contents

Windows/Views

AC3D has a control panel, on the left, plus 4 other windows - three 2D orthographic views and a 3D view. Here's also the menu and toolbar at the top and an information bar along the bottom.

Control Panel

This is where you control the edit mode and draw modes in AC3D. It also contains the surface controls, the palette of materials and the object name field.

The top of the control panel shows information about the current selection, size and position. When the mouse is being used to interact with models, this will also display current positions, distances moved and other information.

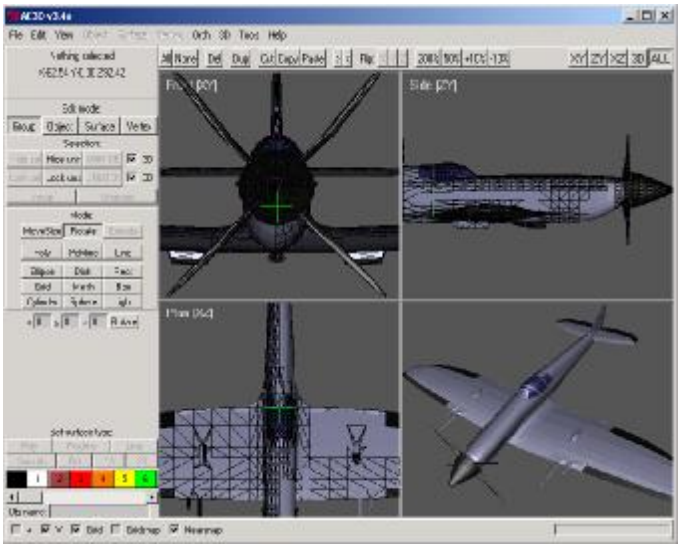
Toolbar

This contains buttons for some of the most commonly used functions.

All – select everything.
None – clear the selection.
Del – delete the selected objects/surfaces or vertices.
Dup – duplicate the selection.
Cut, Copy, Paste – uses AC3D's internal clipboard.
>< - zoom in and out in the orth windows.
Flip XYZ – flip the section about this axis
200%/50%/+10%/-10% - scale the selection.
XY/ZY/XZ/3D/ALL – Maximise a single view or view ALL together

Orthographic views

You primarily interact with models via the orthographic views and view the model in the 3D window (some selection functions are available in the 3D window). Each orthographic view shows a two dimensional view of the 3d world (front, side, plan). Although it's useful sometimes to work in a single view, seeing all the windows at once really helps when positioning objects and laying out scenes.



The dividers between the 4 view windows can be dragged to resize the views. Select individual view by clicking on the view buttons at the top right of the main window (alternately press F1-F5 for the different views).
The main window size/position and other settings are saved when exit AC3D.

The grids

In the orthographic windows, there are two grids - the draw grid and the snap grid. Both can be set from 'File->settings' and can be toggled by pressing the switches at the bottom of the control panel.

The draw grid is purely for visual guides in the orthographic windows.

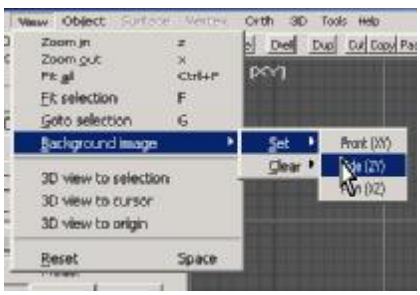
The snap grid (if on) will snap moving/resizing/creating mouse movements to an invisible grid.

Both grids don't need to be set the same but they can be.

Using Background Images

Each of the orthographic (2D) windows can display a background image. This can be very useful for tracing shapes or laying out objects in relation to some scanned image e.g. a map. Background images are set and unset from the View menu. All the image formats that are supported by AC3D's texture loaders can be used.

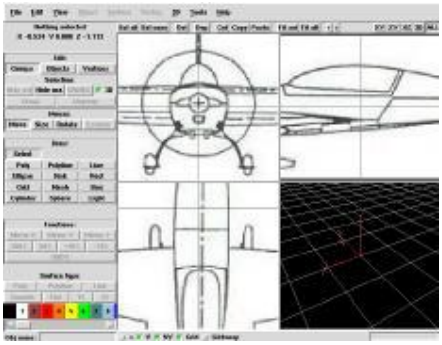
Load and clear background images from the view menu.:



Background images will scale and move with the views. By default, the image will

be centred around the origin. You can move the background image by using alt and the cursor keys. You can adjust the scale of the image using alt+shift then cursor up/down.

Note that the details of background images are currently not saved when you exit AC3D.



The 3D view

The 3D view allows you to instantly see changes made to your model and a preview of the lighting. A fast lighting model is used which will highlight but not show shadows. The 3D window is primarily for viewing your models but also allows you to select objects, surfaces and vertices (depending on the Edit-mode) by holding down the control key and clicking.

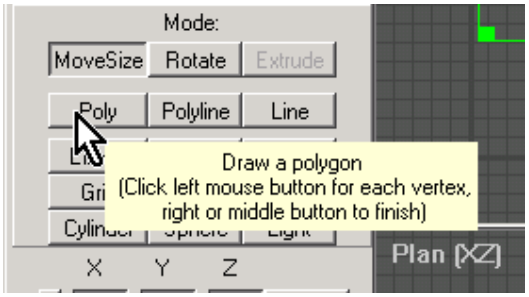
Two navigation mode are available in this window – ‘spin’ and ‘walk’.

A 3d grid is available - toggle with 'g'. the grid is always on the XZ plane (floor).

A single light is provided. It can be switched with 'l' or by using the item in the 3D menu on the control panel.

Getting help

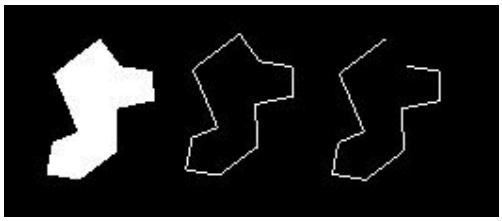
User interface components in AC3D have ‘balloon help’. Small ‘tooltip’ widows will popup when you rest the mouse pointer over a button or field label.



When browsing throiught the menu items, the function on each item is described in the message text at the bottom of the AC3D window.

Creating AC3D objects

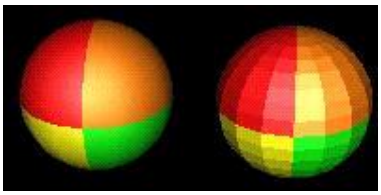
AC3D Surfaces



Objects in AC3D consist is a list of vertices and a number of surfaces that use the vertices. A surface may be one of three types - Polygon, Polyline or Line. A polygon is a filled area, a Polyline is a wire-frame outline of the polygon (a loop that joins the start vertex to the end), a line has a specific start and end.

Surface type is changed by selecting some surfaces and pressing a Surface-type button. These are near the bottom of the control panel (Poly, Polyline, Line):

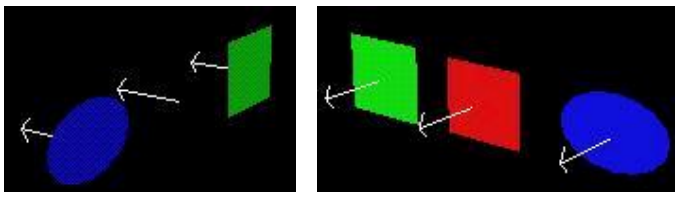
This panel also contains controls to set surfaces to be smooth ‘SM’ or flat ‘FL’. This determines the way that a polygon is drawn (it has no effect on lines or polylines):



If a surface is flat-shaded, the colour across the surface will be constant. If it's shaded then the colour will be 'graded' depending on lighting conditions.

Vertices can be shared between surfaces (i.e. one or more surfaces use the same vertex). If these surfaces are set to smoothed, the effect is of one continuous 'smooth' surface. The vertices MUST be shared for two surfaces to be smoothed together. This shading is a good way to make smooth looking objects from relatively simple shapes.

The '1S' and '2S' buttons select how many sides a surface has. (one sided or two sided). If a surface is single sided then it will only be visible from one side. The following pictures aims to demonstrate this:



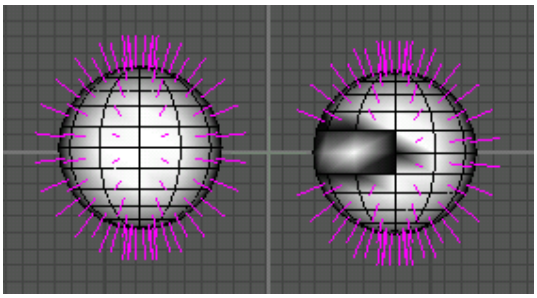
In this simple model, there are three objects - a green rectangle, a red rectangle and a blue ellipse (made by creating an ellipse object and setting it's surface type to be POLY). The red rectangle has been set to be single-sided '1S'. This means that it's visible from it's 'front' but not from the back (the second image shows the whole model rotated). Objects such as spheres and cubes, which don't have any interior surfaces visible, benefit from a speed optimization when being drawn with the surfaces single-sided.

Surface normals

The direction a surface is facing is determined by it's 'Normal' (indicated by arrows in the above diagram). This is a 3D graphics term for a line at right angles to the surface that indicates a direction.). Normals are used in the renderer's lighting calculations. For smooth shading, vertex normals are calculated by averaging normals of all connected surfaces.

Normals can be visualised in both the orthographic and 3d views ('Normals' on the orth and 3d menus). This preview is useful for solving problems where for example some surfaces in an object are the wrong way around (this can cause surfaces to appear missing if they are one-sided, or the smoothing can appear uneven. Viewing the normals is also with the extrude function.

This picture shows two spheres. The one on the left show the normals are correct. The other shows that some surfaces are facing in the wrong direction. Notice how the shading is not consistent.



AC3D automatically calculates the normals (both surface and vertex).

To flip the direction of a surface, use Surface->Flip normal. (This actually reverses the order of the vertices in the surface so that the automatically generated normal faces the opposite way).

Creating new objects

To create an object in AC3D there is palette of shapes on the control panel:

You create objects by selecting one of these button and clicking/dragging in one of the orth. windows.

Polys/polylines/lines

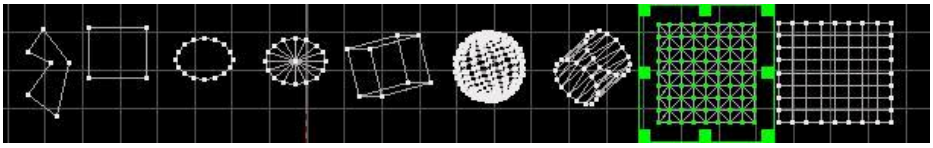
To create a poly/polyline/line, click to position each point and either double-click or press the middle or right mouse button to end. You can alter the surface type later from the control panel if you need a different type.

These objects consist of a list of vertices and a single surface. It's possible to 'merge' these surfaces into larger objects. To help with lining up points with existing points, use the 'near-snap function (toggle a the bottom of the AC3D window)-this automatically pulls new points to the nearest.

Polygons should be 3 or more points. Concave polygons are handled by AC3D. They can be converted to triangles by using the Surface->triangulate function.

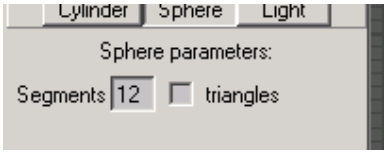
It is actually possible to draw a line or poly in different windows - creating a non planar object. This is fine with lines but is not correct for a polygon which should have all it's points on the same plane.

Sphere's boxes etc.



Dragging in a window allows you to specify two of the dimensions for the new object - the third is specified from the 3D cursor. You can move this by holding ALT down and dragging the cross around with the mouse. This specifies the missing position. Most people never use this because it's easy enough to create an object and position it where you want.

Some objects allow parameters to be set before creating the object. E.g. spheres and Meshes can be made from triangles or quads. Controls for any available parameters will appear in the control panel underneath the mode box.



You should make objects from triangles if you intend more pull the vertices about, otherwise you may have non-planar rectangles which can cause problems with some renderers and raytracers.

Objects can be named - these names are used when generating output files. The object name box is at the bottom of the control panel.:

Object names can only be edited/set in Group or Object edit mode. Object names can be the same across 2 or more objects. This can be useful for selecting or finding particular objects with the Edit->select-by-name function (e.g. you may want to select all objects named 'chair').

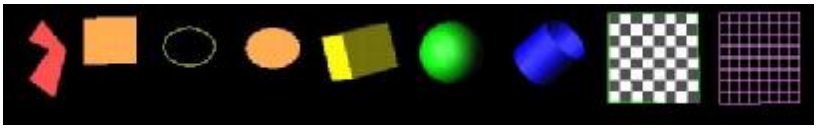
If you are generating VRML or Dive files, you can associate URLs and other text with selected objects. This text can be used in a number of the export file formats that AC3D uses. The names, text and urls are saved in the .ac AC3D files. Enter text into the field on the Tools->Object Data window. Object names can also be set in the same dialog.

Creating other objects

At first glance, this set of objects may appear limited, however, it's very easy to create other objects from these shapes. E.g. to make a torus shape ('donut') simply create an ellipse and select the Object->revolve menu.

You can easily make a cone in a number of ways. Create a cylinder, select one end (in vertex mode) and press 'snap together'. A cone made this way will have the texture coordinates set correctly. For a simpler cone (fewer vertices), no texture map) you can optimize the vertices. This means that the cone's point will be one vertex which is shared with all the sides (texture mapping this object will probably not give satisfactory results). Some other ways of making cones are - make a 'disk' and pull the centre point up; revolve a line around an axis. If you want a base on the cone then - select the bottom vertices and select 'Vertex->Create surface/object'.

Use 'Extrude' to add extra parts to objects or give 2d shapes depth. You can also cut objects into pieces and delete specific surfaces.



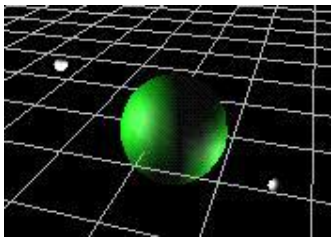
Lights

Lights are a special kind of object - they have no associated geometry. At the moment there is only one kind of light - a point light. This is represented by a point in space marked with this symbol: You will not see anything displayed in it's position in the 3D window but you should see the effects of the light on other objects in the scene. Note that there are no shadows - objects that should obscure the light will not.

Lights are fixed brightness white lights. Select and move lights in Group or Object select mode.

Lights are generated in POV files and RIB files. You can easily edit their attributes in the generated files.

This image shows a green sphere with two lights (indicated by white spheres) - the main headlight is off. The headlight in the 3D window is toggled on and off with the 'l' key (or from the 3D menu). If the headlight is on when POV or RIB files are generated then a light will be added to the file.



Text

Add-Text is a simple function which allows a set of objects in an AC3D file to be treated in a similar way to a text font. You can view the AC3D font file by simply loading it in to AC3D. Essentially, you have a set of objects which are named to be letters in the alphabet (and other symbols too). Add Text takes a string (e.g. your name) and duplicates these objects, laying them out next to each other. The text will be created at the origin and will usually be facing so that it's viewable in the XY (side) window. This text will be selected and you can move/resize/rotate it anywhere in the scene. Extrude the text to make it 3D.

Making your own fonts

A file for use with Add Text is simply an AC3D file with named objects - the only special thing that you need to do is to ensure that the objects have their centres minimized (set using the Object->Minimum centre function). To view object-centres you need to ensure that the '+' button is on (at the bottom of the control panel). This point is used when lining up text objects. The point is taken as the start of the 'character' and the width of the object is measured so that the next character can be placed the correct distance along the line, without

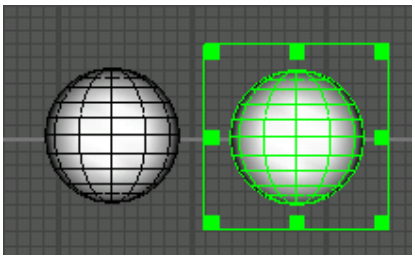
overlapping. The font file should be designed to be viewed from the front in the XY window, since these coordinates are used for positioning the font objects.

You may find the Add text function useful for storing a library of objects e.g. furniture. Each object can only be indexed by a single character.

To create accurate 3D text objects from TrueType fonts (as used by Windows etc)- use **Font3D** to generate DXF files and import them into AC3D. Font 3D is free to download from http://www-personal.ksu.edu/~squid/font3d.html Registered users benefit from a special Font3D plugin.

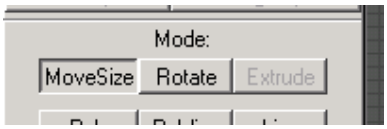
Font3D may no longer still be available from this location. See the AC3D resources page for more information on how to create text from true type fonts.

Selecting, resizing and moving



In AC3D, you select and drag vertices just like a 2D drawing program. The majority of selection and manipulation is done through the orthographic windows although selection is possible via the 3D view.

Selected components (surface, vertices) are shown in a different colour and are surrounded by a 'bounding box' (usually green).

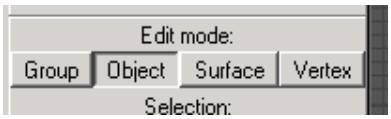


Selection is possible in mode/size, rotate and extrude modes. The default mode is move/size.

Note that the extrude button is disabled in this picture – it's enabled only in surface edit mode.

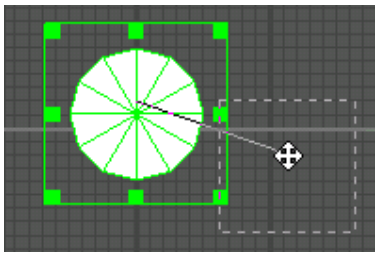
To select, drag a box over the area you are interested in. The Bounding-Box that then appears can be dragged or resized directly affecting the points/surfaces/objects selected

Selecting



The edit-mode defines the granularity of selection. In Vertex-mode you can drag a box around or click on a single vertex. In surface-mode you can select one or more surface by either clicking or dragging over an area. In Object-mode selecting any part of an object causes the whole object to be selected. In Group-mode you can select a group of objects just by selecting part of a single object.

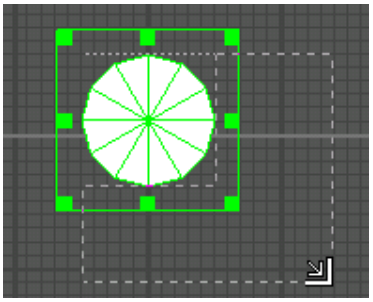
Moving



If you drag the green box you can reposition the selection. Holding the control key down whilst dragging lets you constrain movement to up/down or left/right only.

Resizing

Drag the handles in the corners of the bounding box to resize the selection. On the edge handles, hold the control key down whilst moving the mouse to resize opposite edges.



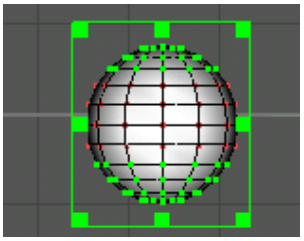
The control key currently has no effect on the corner handles. Note that it's possible to resize a selection down to zero width. This is useful for lining up vertices.

Extending/Negating the selection

Press shift whilst selecting to extend the selection and press shift whilst selecting with 2nd (or 3rd) mouse button to negate the current selection.

Extended and negate selection work in all select modes e.g. you can add/subtract whole objects from the selection when in object mode.

This picture shows the top and bottom of a sphere selected.

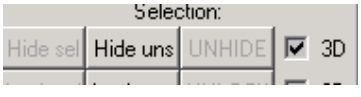


To unselect everything, press the 'None' button in the toolbar, menu Edit->select-nothing or click the mouse outside the bounding box.

Selecting in the 3D window

Hold the control key down and click on a component to select it. This also works in a similar way to selection from the 2D windows - you can extend or negate the selection in the same way.

Hiding objects



This allows you to temporarily remove objects from the views and means that you can work on much larger models. You can hide selected objects and hide objects that are not selected. Press 'unhide' to show all objects. The '3d' toggle determines if the hidden objects are visible in the 3d window.

Locking objects

This is useful for temporarily disabling objects that are obscuring others. When objects are locked, it's not possible to select them.

Locking also helps with the performance when editing large models. It works in a similar way hiding, only that locked objects are drawn in grey wireframe.

Note that if objects are hidden (or locked) and you save/export the model, hidden/locked objects will also be saved.

Navigation and viewing

Moving the orthographic views

You can shift the views in the orthographic windows with the cursor keys. Press shift with the cursors keys to move in larger steps. Zoom in and out with control and the cursor keys or 'z' to zoom-in, 'x' to zoom out.

Dragging the mouse when holding down the middle button ‘pans’ the window. The right mouse-button zooms. If you don’t have a middle mouse button, holding down the control key and using the right mouse button will pan the view.

You can set the window zoom to be the same inside settings dialog (select the File->edit settings menu), otherwise windows will have independent zoon settings.

Navigation in the 3D window

There are two viewing modes accessible by pressing '1' and '2' in the 3d window (or by selecting the menu items in the '3d' menu):

Spin mode

In 'spin' mode - rotate the view by holding down the left mouse button and dragging. Zoom in and out by holding down the right mouse button and dragging the mouse vertically. If you have a middle mouse button, holding this down and dragging will ‘pan’ the view. If you don’t have a middle mouse button, holding down the control key and using the right mouse button will also pan the view.

Press 'w' to toggle between wireframe and filled drawing, 't' toggles textures. 'l' toggles the fixed light. There are switches for the viewing mode in the 3D menu. The cursor keys can also be used to control the spin (control plus up/down zoom in/out).

Walk mode

You can navigate using the cursor keys (in a similar way to 'Doom/Quake'). You must be in walk mode. '2' switches into this mode ('1' switches back to spin mode). Use up/down the cursor keys to move, left/right to turn. Pressing control with the cursor keys tilts your position and alt moves you left, right, up, down.

You can also control walking with the mouse (this is actually more like ‘flying’) - the left button turns and moves forward and backward, the right button controls up/down/left/right movement.

Resetting views

Press the 'space' key (when the mouse is over a window) to center that windows about the origin and reset the zoom levels.

Viewing the selection

Press 'f' to fit the current selection into the current window. 'F' fits the selection to all windows. Control-F fits the whole model into all views. Use 'g' to 'goto' the current selection - the window will centre about the centre of the selection. 'G' centres all windows. These options are also in the View menu.

Three functions available from the View menu allow you to centre the 3D view about the selection, the cursor (that's positioned with ALT-click in the 2D windows), and reset to view the origin.

Model manipulation

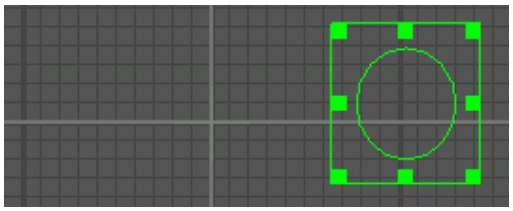
Operations on objects

To perform any of the operations on the object menu you must have the select-mode set to group or object.

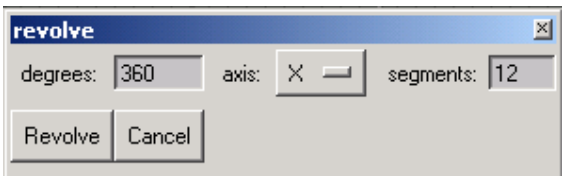
Revolving

Revolving make copies of the selected objects, rotating each copy, then it creates surfaces between the copies. This means that it's best to revolve 2d outlines of shapes rather than filled-polygons. Any revolved line objects are automatically removed after the revolution. You select the axis to perform the revolution about.

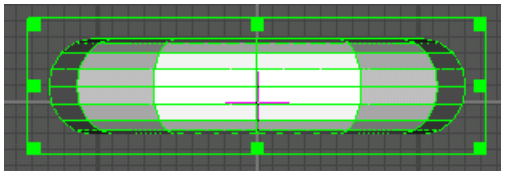
To create a torus -make a circle in the Front window:



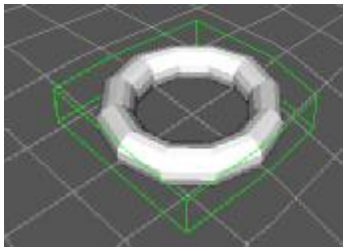
Select 'Object->Revolve…'

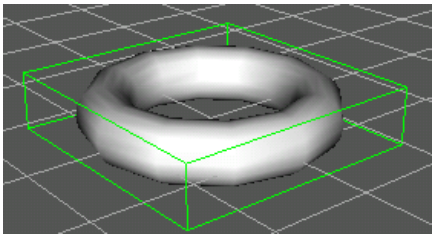


Set the axis to Y and click Revolve. You should see something like this:

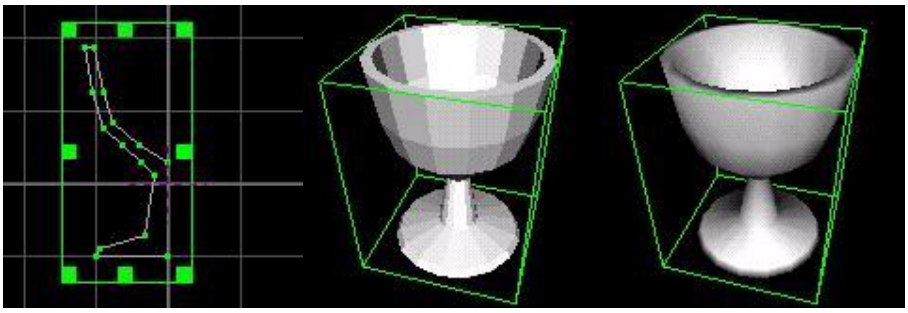


Select the 'smooth' surface type (near the bottom of the control panel) to make it appear rounded





You can also change the degrees of revolution 1-360 degrees.



If you have points that you want to be in the centre of the final revolved object - (e.g. the start and end points of the cup profile above) then you should ensure that these points lie exactly on the axis. You can do this by either drawing the line with 'gridsnap' on or by snapping those points to the grid or by using Move-to and ensuring that two of the values are zero. If these points are not exactly on the axis then you'll get a small hole or possibly overlapping surfaces (you can always use the 'snap together' function and optimize vertices or remove duplicate points later though).

Optimize Vertices

This function removes duplicate vertices from each selected object. For vertices to be removed an object must own the vertices and they much match the same position exactly. The function will share one vertex between each connected point. This means that vertex normals can be calculated if smooth shading is needed. It also removes duplicate vertex references from the surface - something that might cause a bad polygon.

Optimize Surfaces

Attempts to remove any duplicate surfaces and any polygons that consist of 1 or 2 vertices (you may have these if you have deleted vertices from an object).

Re-centre

If you have object centres visible ('+' at the bottom of the control panel) then you can re-centre this point about the objects centre of gravity. This can be useful for specifying where the pivot points or local-origin of an object are.

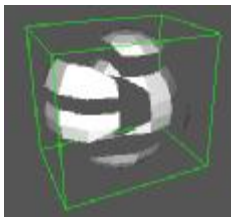
Minimum-centre

This function sets the object's origin to the minimum xyz of the object. It is used to create AC3D fonts for the Tools->Add-Text function.

Fragment

Make a selected object into many objects - one object per surface of the original object. This is useful if you want to break an object into pieces or for texturing

each surface with a different picture. This image shows a sphere that has been fragmented and new objects have been moved apart. Notice that the surfaces are no longer 'smoothed' together - this is because each surface is now a separate object and vertices cannot be shared across objects.



Merge

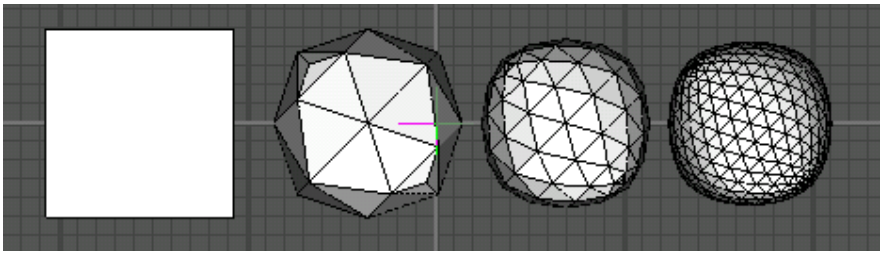
Places all the surfaces selected objects into one single object. This does NOT optimise the vertices so that they are shared. (You might want to select 'optimise vertices after merging if you want a more efficient object and/or smooth shading across adjacent surfaces)

Explode

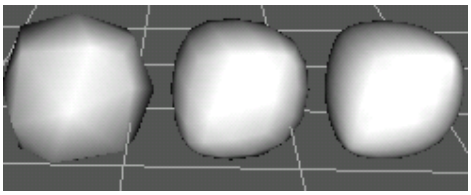
This is similar to fragment, you enter a distance and each surface in the select object is moved by this amount.

Subdivide surfaces

This function can be used to ‘smooth’ the edges of an object. This picture shows four cubes. The first is a standard box, the others have had surface subdivision applied one two and three times.



Currently, the surfaces will always be flat after this function. You may want to select the objects and press ‘SM’ on the control panel to smooth them:



Note that this function always creates triangles. Each subdivision quadruples the number of triangles in an object.

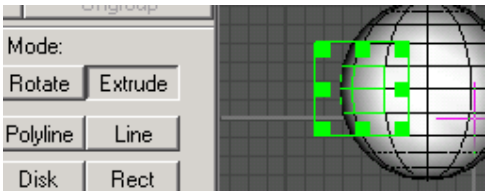
Operations on surfaces

Extruding

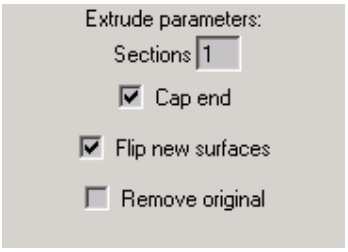
Extruding work only in surface mode. Pressing the extrude button on the control panel when there are one or more surfaces selected enables the function. The actual extrude is done after you drag the selection.

Extruding is a very powerful function that can be used for a number of tasks. It works by making new surfaces at the edges of the current selection. The original selection can be removed and/or copied to the end of the new surfaces.

Selecting one of more surfaces and selecting the extrude button on the control panel, brings up the extrude parameters:

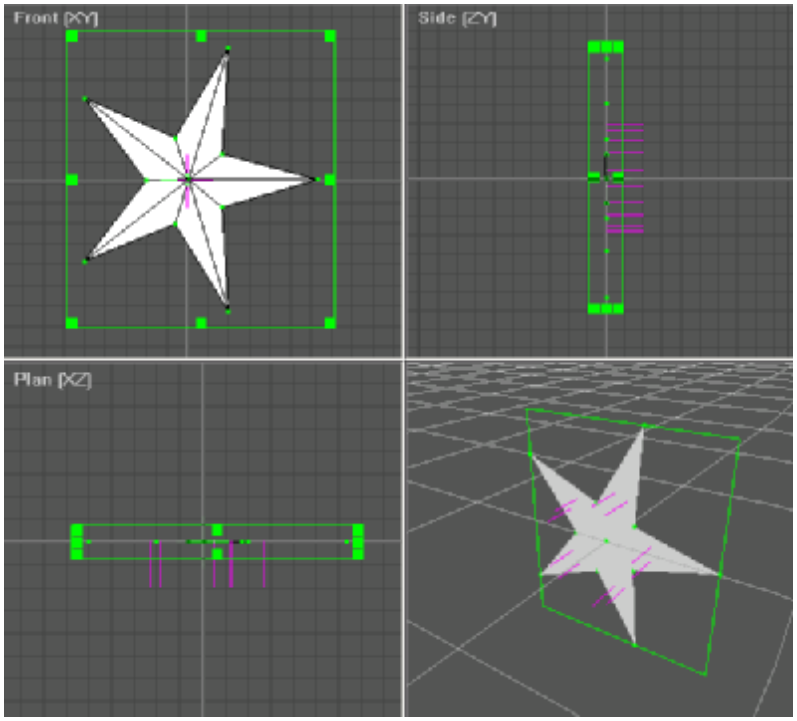


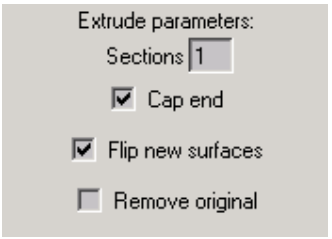
Here you can choose how many new sections to produce, weather to cap the end with a copy of the original selection, flip the normals of the new surfaces and whether to remove the original surfaces.



After setting these parameters, you drag the bounding box in the direction you want to extrude. (You can hold down the control key as you first drag, this will constrain movements to horizontal or vertical.)

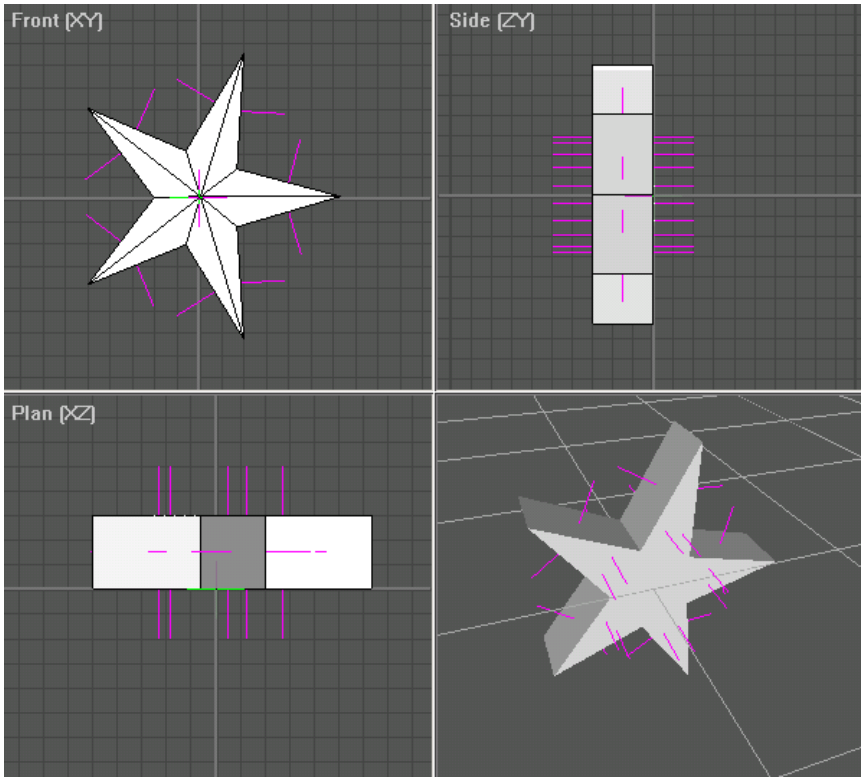
The extrude function is best demonstrated with some examples. This star is made by creating a 10-sided disk, selecting alternate vertices and shrinking the selection (using the –10% toolbar button a few times).



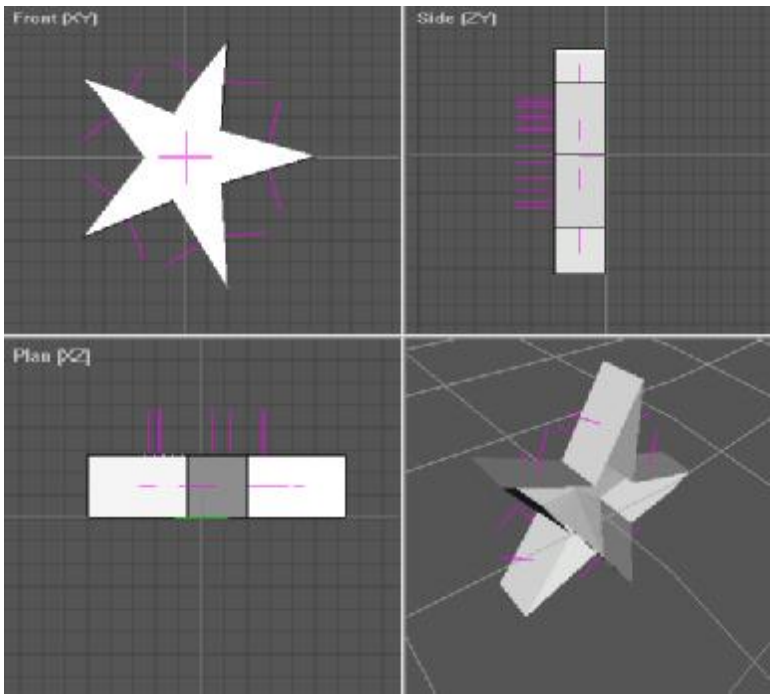


Note that the magenta lines shown here represent the normals. This is useful because it can be used to determine which way to extrude the object to keep the surfaces facing the correct direction. In the extrude, if you drag the selection in the same way as the normals, the resulting shape will hide the front of the original surfaces. This is good if you are, for example, extending one side of a box, but in this case we want the original surfaces to be on the outside of the final shape. This means that we want to drag the surfaces in the opposite direction that the normals face. Because we are doing this, we need to 'flip new surfaces' so that all the new surfaces face outwards.

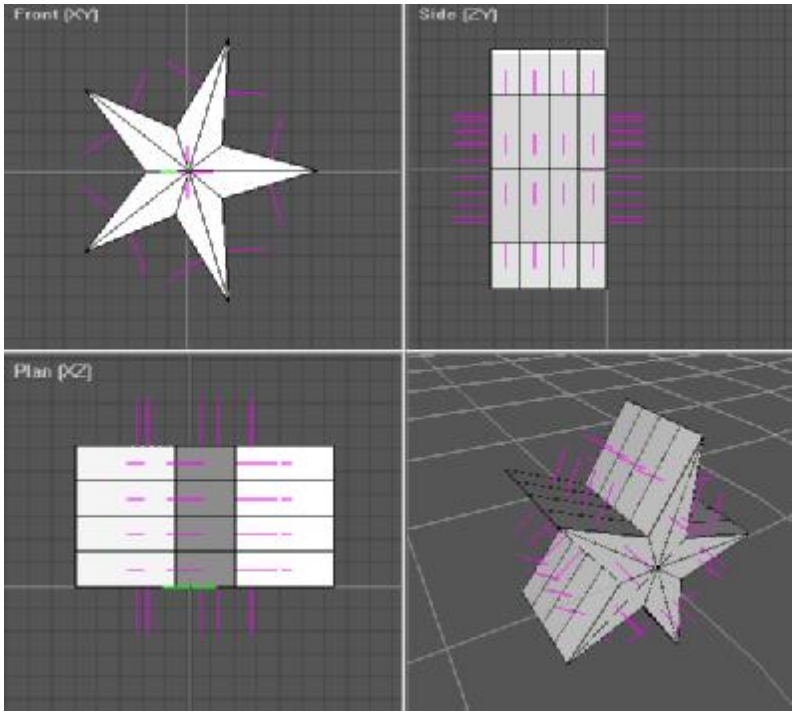
This is what happens when we drag the selection up in the plan window.



If we ticked ‘remove original’ here then the star that we are dragging will be deleted:



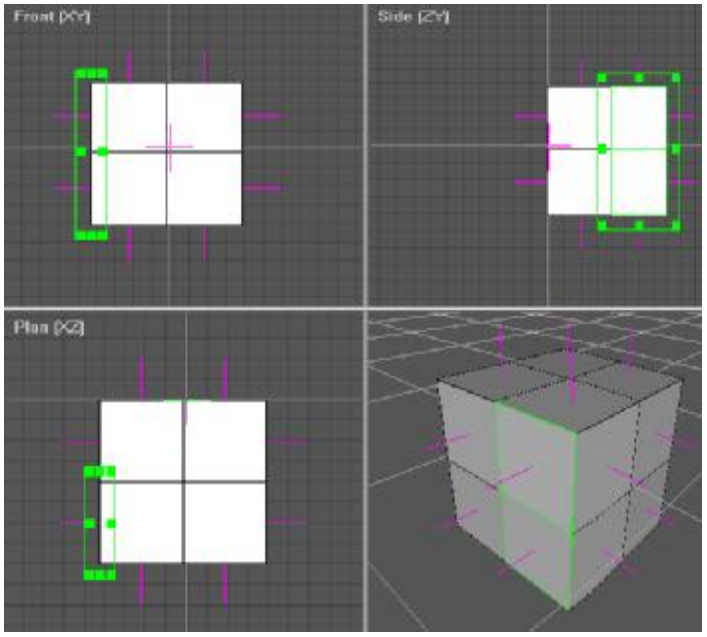
Here you can see that the original surfaces have been removed to leave a start shaped box (without a lid). If we’d un-ticked ‘cap end’ then we’d be able to see right through the star shape.



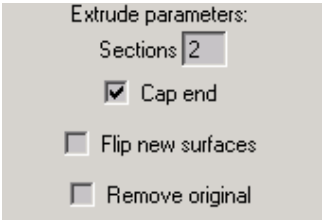
This picture shows what happens when sections is set to 4.

If you need to extend an existing set of surfaces, you may not want to keep the existing surfaces inside the new object.

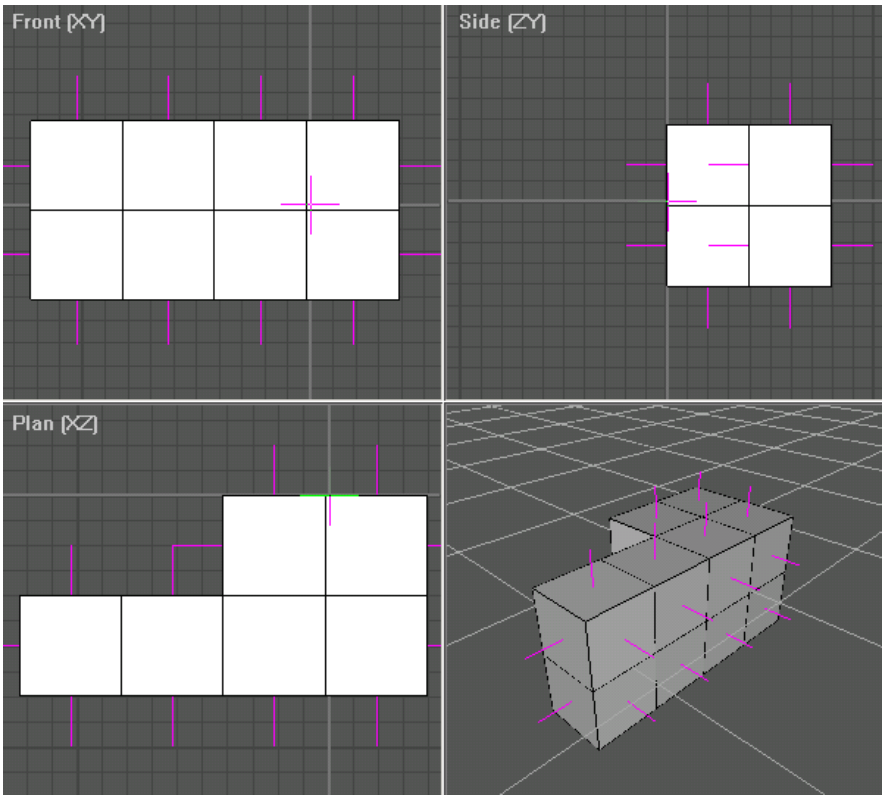
Here is a cube that has had 'Surface->divide'. Two of the surfaces are selected.



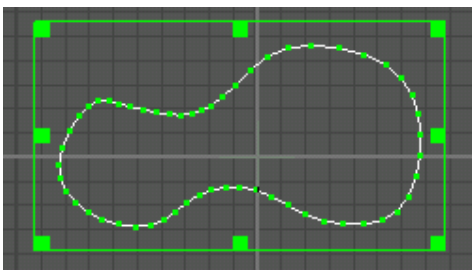
We can extend these surfaces without keeping the original surfaces (since they will not be visible because they are inside the shape. We use these settings:

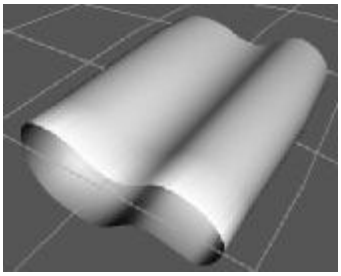


To perform the extrusion, we drag the bounding box to the left (in either the front or plan window), holding down the Control-key as we drag to ensure that the new surfaces are square to the original. This gives:



When extruding lines, you will probably want to ensure that remove original is ticked and cap end is un-ticked. This ensures that no lines remain in the new surfaces.





It's useful to switch on the display of normals when extruding so check that the resultant surfaces are facing in the correct direction. If they are not, use surface->flip normals.

Flip normal

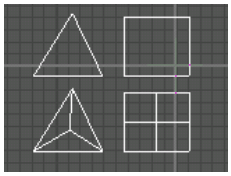
This effectively changes the direction of the vertices in each selected surface. This reverses the way that a poly 'faces'. A polygon is defined as 'facing' if the vertices appear anti-clockwise to the viewer. If a polygon is set to be one-sided (by pressing the '1S' button on the control panel) then it will only be viewable from one direction - the direction it is facing. You can switch on the display of normals I the orth and 3D windows – this can help determine if any surfaces are facing in undesired directions.

Change vertex order

This changes the order that the surface vertices are drawn by moving the first vertex to the end of the surfaces vertex list. You can use this to change where the break in a line is. This can also be used to fix bad polygon, which has the first three vertices in a non anti-clockwise order - causing the normal (used for lighting) to be incorrectly calculated. If a polygons shows up as all black, it may need this function executing on it until it appears correctly.

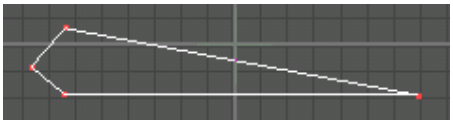
Divide surfaces

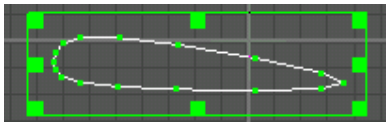
Divide only works on triangles and quads. It makes 1 triangle into 3 surfaces (new vertex at centre). Splits quad into four smaller quads.



Spline surfaces

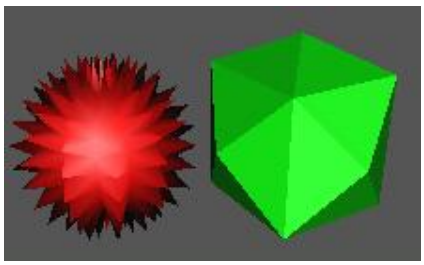
Useful for smoothing out a 'line' object and for rounding off polygons. New points are interpolated between existing points.





Spike

Creates a 'spike' in place of each quad or triangle selected. The 'spike factor' in the dialog that pops up - this defines the distance that the apex of the spike will be away from the original surface.



Make hole

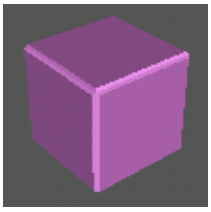
This image shows 4 objects that have had holes made in them - An Ellipse (set to poly surface-type), a sphere, a cube and a disk. Notice how you can't see the inside of the sphere or cube through the holes- this is because the default surfaces for these objects are single-sided and face outwards. To see the insides though the holes, you'd need to select these objects and press '2S' on the control panel.

Some concave polygons may have overlapping surfaces after making holes - you might need to move some of the vertices.

The size of the hole is specified as a percentage and can be adjusted in File->settings.

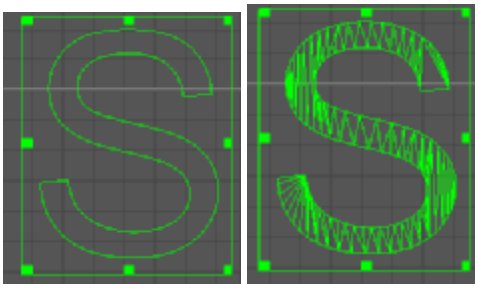
Bevel

Creates another surface, which is smaller than the original, moved away slightly and joined by new surfaces around the edge. The original surface is discarded. The distance the new surface is moved and indented is specified in File->settings (Bevel size). Bevelling a concave polygon can result in new points being positioned incorrectly you may need to move these



Triangulate

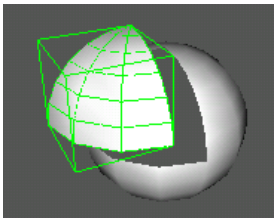
This spits non-triangles (i.e. polygons with more than 3 sides) into more surfaces, each new surface being a triangle. The operation can fail if it is given a 'bad' polygon - i.e. one that has overlapping edges or duplicate vertices.



Some surfaces in file formats generated by AC3D are automatically triangulated (if they need to be) - some are not though. Renderers that can't cope with concave polygons may give odd results if they are given them.

Cut away object

Takes all selected surfaces and vertices and puts them in a new object. This can be useful for extracting parts of objects. e.g. splitting a sphere into two.



Remap texture coors

see texturing section.

Operations on Vertices

The Vertex menu is only available when the Vertex edit mode is on and one or more vertices are selected.

Snap-together

This sets all selected vertices to the same location. The vertices can be in separate objects or the same object. The point that they are snapped to is the average of each point.

Snap-to-grid

Moves each selected vertex to the nearest grid position. This may or may not be the visible grid. The snap grid is defined by 'snap grid' in settings and may be different to the 'draw grid' (which is the visible grid).

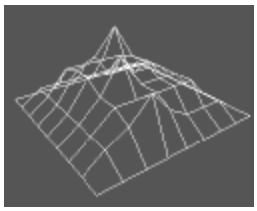
Snap-objects-by-vertices

This is for aligning two objects. You must select one vertex in each of two separate objects. The objects will be aligned by shifting the objects together so that the two selected vertices are in the same place.

Snap object vertex pairs

This looks at vertices that are selected in two different objects and snaps adjacent pairs together. This is useful for joining the ends of two objects together,

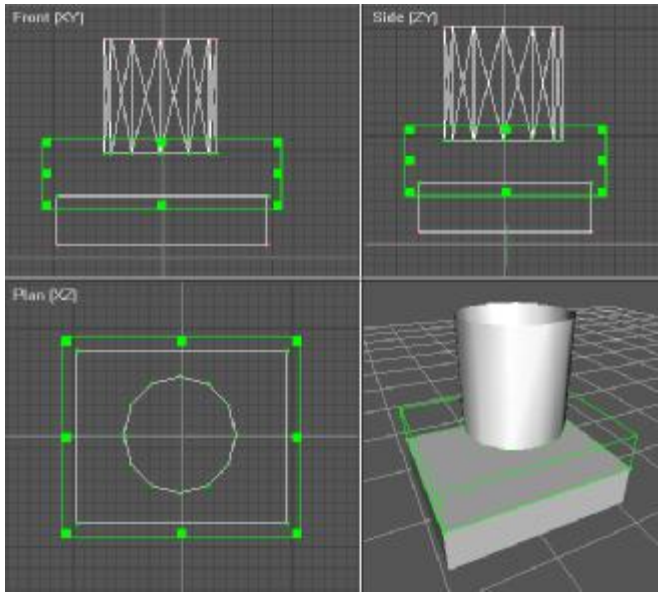
Insert Vertex

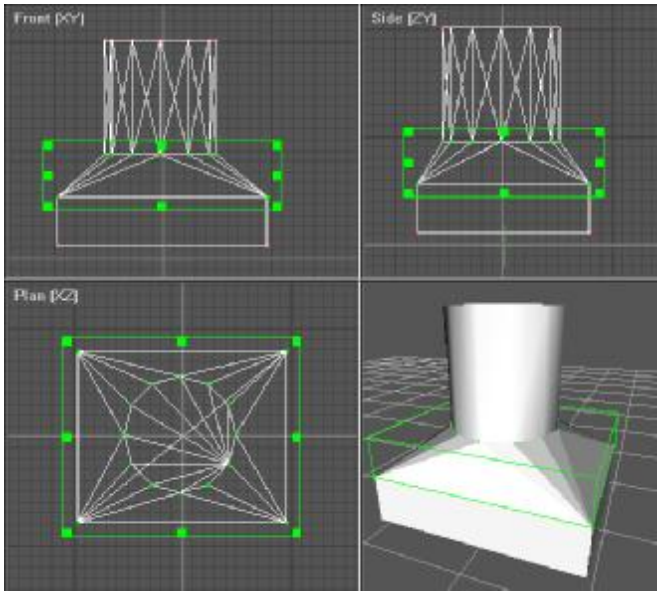


Inserts a new vertex between each selected pair of vertices. If you insert a vertex between two vertices of connected surfaces (i.e. along a shared edge) then two different vertices will be made. If you want these to become the same vertex then you should select the object and choose Object->Optimize vertices. Insert-vertex is useful for adding extra points into a line. An example is to create a grid object (which is made from lines) in a power of 2 dimension e.g. 8. Press 'Insert vertex' 3 times (2^3=8). You should now have a grid where you can lift each point and create a 3d graph.

Create surface/object

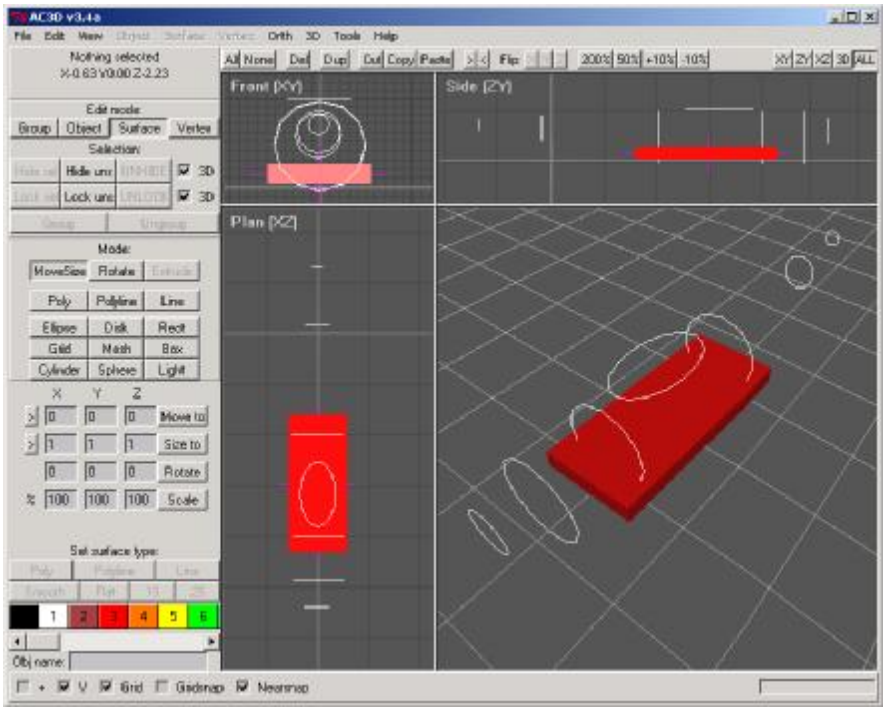
This function uses a technique called 'convex hull' to create a new object that surrounds the vertices that are selected. This is very useful for joining complex objects together or for simplifying the creation of some complex shapes.





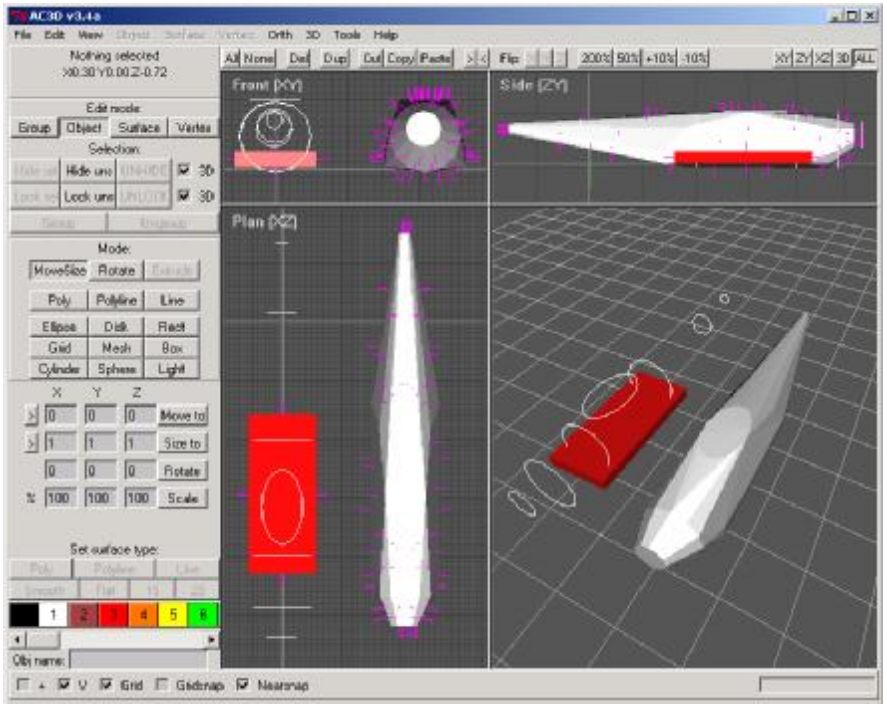
These two pictures show the function being used to join a cylinder to a cube. The new object will always be flat shaded but you can set it to smooth by pressing the "sm" button on the control panel. Note that because this function makes a new object, the vertices are not shared with the old objects. If you want to make the whole shape smooth then you need to merge all the objects together (object->merge) and then optimize the vertices (object->optimize-vertices)

A second example uses a number of simple objects, which are 'shrink-wrapped' by this function. In this case we are creating the fuselage of an aircraft. The objects are ellipses and a single red box. Any AC3D objects can be used this way, either lines or polygons. The color of the objects is not important. It's the actual vertices that are used in the calculation.



To get a more accurate outline, these shapes could have be made by placing background images of a real aircraft onto the views and building the shapes on top of those images.

And after the Surface->Create surface-object menu function has been selected:



This picture shows the fuselage object created from the simple shapes. It's been dragged to the side of the original objects, which still remain in the scene.

It's important to note that the hull created is 'convex'. This means that if there had been an object that was totally 'inside' the encompassing hull, the new hull object would not have any vertices created at the points on that object.

This function will also create 2 dimensional convex hulls, as long as all of the selected vertices lie on the same plane. If they are not, a 3d object will be created.

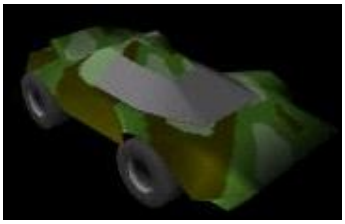
Create ordered surface

Select individual vertices and create a surface between them. You should select them in order and anticlockwise (to get the normal facing towards you). If you need to create your own polygons then it's better to draw 'poly' objects. This function works by creating a new surface and adding vertices in the order they were selected. If you select many vertices and they are not selected in exactly the correct order then a bad surface (crossing edges or non-planar) may be created.

Remove surface only

Remove any whole surfaces selected - vertices will remain.

Texturing



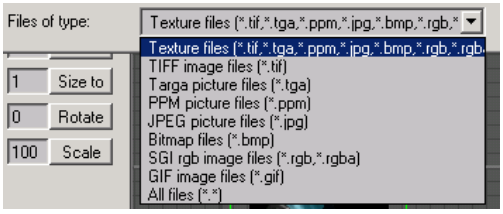
Each AC3D object can have one texture. A texture is set from the object->texture menu. There are default texture mappings set for the primitive objects when they are created, but you might need to remap the texture coordinates. This is done by axis (Surface->remap texture coors). Currently you can map by axis and spherically. To map at an angle, you will need to rotate the object and then select remap-texture-coors->axis.

You can also modify the texture repeat and texture offset in Object->Texture->set texture repeat/offset.

Surface->remap-texture-coors->(front, side, plan) maps the selected surfaces by axis. It finds the bounding rectangle of the selection and uses this for the edge of the texture mapping. Spherical mapping 'wraps' the image around a ball and shrinks it onto the selection.

If you need more than one texture on an object (e.g. a different image on each side of a cube) then you should fragment the object (or use Surface->cut away object) and map a texture on to each of the sub-objects created.

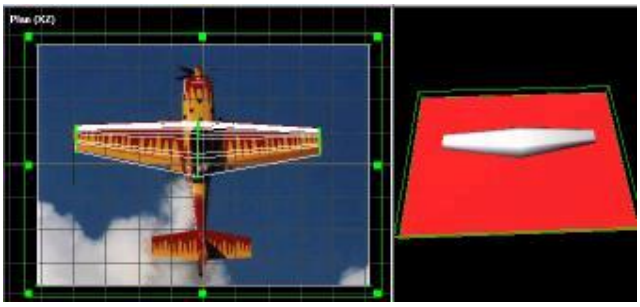
AC3D loads a number of different picture file formats for textures. These include .gif, jpeg etc. More image file formats are available as plugins. To see which formats you can load, see the load texture dialog.



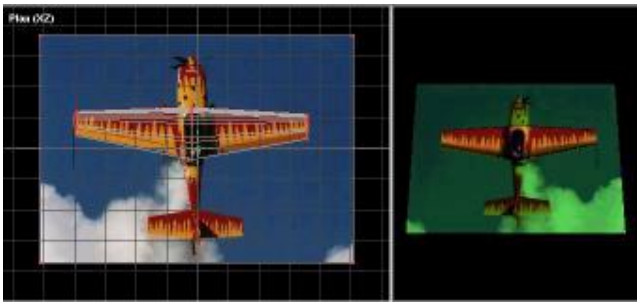
Note that some export formats (or rather the programs that load the files) do not support all the texture file types that AC3D supports. You should ensure that you are using the correct format texture for the correct export file type e.g. .jpg or gif for VRML.

Using textures in conjunction with background images

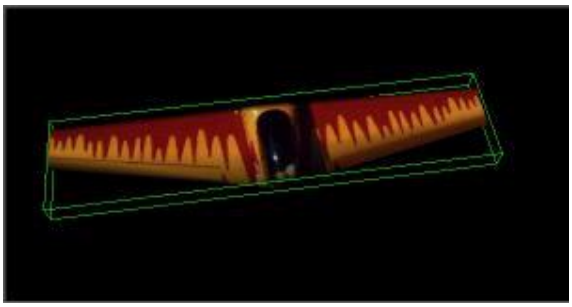
It can be useful to use the background image as a texture on the final object. This example shows how the wing of an airplane model is mapped. The picture of the plane is loaded into the plan view window of AC3D and the wing is built up over it. If the wing object was selected and texture mapped (to the plan axis), you'd end up with the whole picture, including the sky, mapped on to the wing object. The solution is to create a 'dummy' object, in this case a rectangle over the edge of the picture, which when selected along with the wing, makes the full extent of the texture mapping go to the rectangle.



This picture shows the wing object and the rectangle. The rectangle will be deleted later.

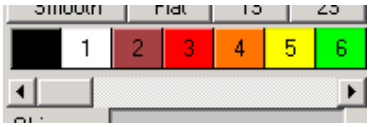


The same model after the selecting Surface->remap-texture-coors->plan in vertex mode.



The rectangle can then be deleted and you have a wing which is correctly texture mapped. Note that the image of the plane's cockpit is in the middle of the wing. The fuselage will hide this when that's added. Making two separate wings and using the same technique would have worked fine too.

Materials and the palette



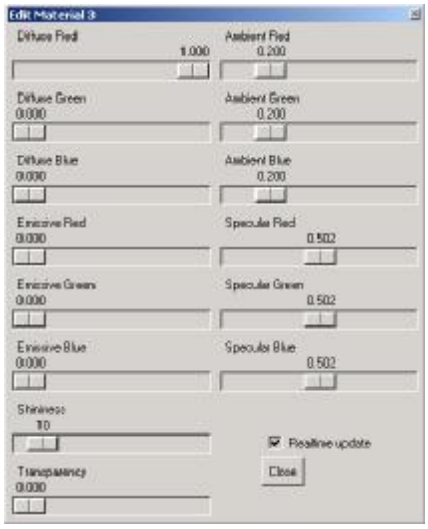
The scrolling window of buttons near the bottom of the control panel represents the colours/materials available for setting on you models. The default colour for an object is palette entry 1 (usually white)

Press a button to select a colour for the selected objects/surfaces. Setting the material of surfaces works in all selection modes but for a surface to change color in Vertex mode it must have all it's vertices selected.

You can affect the overall look of a texture you alter the colour of a surface which is textured (the colour will 'show through' the texture) If you want the texture to appear as the original coloured image then the surface colour should be white.

To find the material index of an existing polygon, select that surface and the message at the bottom of the AC3D window will display the material number.

Editing Palette entries



You can find a menu on each palette button by pressing the right mouse button. From here you can edit a colour or add a new one (a copy of the selected one will be added to the end of the list).

Note that the colour on the palette button represents the diffuse RGB values for that material. It's quite possible to get the rendered colour looking something totally different from that by setting other material parameters.

If you save a model with different colours/materials then palette buttons will be appended to the list when it's loaded in the future.

Transparency is supported in the palette but for purposes of speed, the surfaces are not sorted when they are rendered into the views.

Loading and saving files

You can load and save AC3D format files. An AC3D file is a text file describing the geometry of a model. AC3D files retain all available information about a model built with AC3D e.g. textures, surface settings, materials, object data etc. Other file formats exported by AC3D will not retain all of this information. You should always save your models in AC3D format to ensure that you do not lose this detail.

Developers can view a description of the file format on the AC3D home page.

Loading a file does not clear the current model - this allows you to have a 'library' of useful objects and load them in when you want.

Importing other formats

See the File->Import menu for a list of file types you can import.

Full registered versions of AC3D come with a number of extra Import/Export plugins that handle more file formats – they are not documented here.

Here are some formats that may be useful for importing your own model data.

Triangle files

the format of triangle file is: each line contains 9 floating point numbers and one hex value e.g.: 0.0 0.0 0.0 1.0 0.0 0.0 1.0 1.0 0.0 0xffffff represents 3 vertices of a triangle. hex value is 0xRRGGBB col - in this case white duplicate vertices are aggregated when loaded.

The simple format of triangle files might allow you to import models from other formats more easily than converting them to DXF or something else.

Vector files

This is another simple format for importing 2D vector data. Each line should consist of a number of vertices followed by that many x/y coordinate pairs e.g.

```
3 0.5 0.5 2.5 2.5 10 5
```
This represents a line with 3 vertices (0.5, 0.5)(2.5, 2.5)(10, 5)

Exporting files

AC3D can generate output files for many different formats. Support for extra file formats can be added by plugins. See File->export for a list of the output files supported. Not all are mentioned here.

VRML 1

URLs (set from the object data dialog) are used so that objects will be selectable in the appropriate browser. You can switch output of normals and textures in the File->settings window.

VRML 2

Materials are not present in the file, only colours. This is due to a backwards step in the design of VRML2 - you can only index colours, not materials. URLs (entered in Dive object data) are ignored. Output of normals and textures is switchable via Settings. Note that texture files are supposed to be a different format in VRML2. They were RGB in VRML1 but this has been changed.

DIVE

Dive files will handle textures. The Dive generation will include the dive data (if you have input any) this is usually TCL code. If an object has a URL then the object will be a dive gateway. See www.sics.se/dive for more info about the Dive VR system.

MASSIVE

Massive is a distributed VR tele-conferencing system written by Chris Greenhalgh at Nottingham University in the UK. It runs on SGI and Sun platforms. For more details, see:
http://www.crg.cs.nott.ac.uk/~csm/massive.html

RENDERMAN

These files are used in a raytracer. See http://www.bmrt.org for a good rendering tool (BMRT) and other pointers to Renderman related stuff. The eye viewpoint is defined by your view position in the 3D window (approx). Note that lines don't make sense in a raytracer and will not be output. If you get any polygons with one or two vertices only, you may get a bad-polygon message. If you want to clean these away use 'Object->optimize surfaces'. Textures from picture files are not supported although there may be a way that this can be accomplished by using a custom shader - see the URL above for more details. Any polygons that need triangulating (breaking up into triangles) will be triangulated.

POVRAY

Povray is a very popular raytracer see www.povray.org for more info. The eye viewpoint is defined by your view position in the 3D window (approx). The colour palette is output at the top of the file (each entry has the same number as the AC3D material). The properties can be altered easily to provide different surface types and textures (you might need to add some #includes to get

external definitions). The light is output at the end of the file. The lights position is the same as the viewers. The POVRay output is based on triangles - lines will be ignored and polygons with > 3 vertices will be triangulated automatically.

The latest povray exporter supports textured objects. You should ensure that the format of the texture picture files you use are compatible with POVray. You may need to Surface->triangulate objects before outputting them to povray file.

Triangle files

see loading triangle files for a description of this format. This format is very simple and is easy to parse.

Rendering

The "Render" button in the tools menu can be configured to automatically launch your favourite renderer. The command executed when the button is pressed is entered in the settings.

The command is actually a TCL string. TCL commands are separated by ';'. by default, AC3D is configured to generate a POV file, then execute povray. An example command for POV is:

```
ac3d write_POV ac3dpovfile.pov ; ac3d execute {"C:\Program
Files\POV-Ray for Windows v3.5\bin\pvengine.exe"  /RENDER
ac3dpovfile.pov }
```

you may need to edit this command and set the correct location of the povray program.

and for BMRT:

```
ac3d write_rib /tmp/ac3dribfile.rib ; ac3d execute { rendrib -d
/tmp/ac3dribfile.rib &}
```

The first part sends a message to AC3D to write a POV file. The second part sends a message to AC3D to execute the povray program. This will only work if povray is somewhere on the default search path - you might need to specify a full pathname to the binary program. The execute command must be surrounded by {} NOT quotes (").

Under WINDOWS it's slightly different:
ac3d write_POV ac3dpovfile.pov ; ac3d execute {"C:\Program Files\POV-Ray for Windows\bin\pvengine.exe" /RENDER ac3dpovfile.pov }

For other renderers - the other AC3D write_ commands are:

```
write_dive
write_vrml
write_massive
write_rib
write_POV
```

Appendix

Performance tips

Rendering more polygons takes more time. As you edit and create more objects, the rendering will take longer. Here are some tips to help you edit larger models more effectively.

Switch to wireframe viewing. This is much faster to render.

Use object hiding and locking. This reduces the graphics load.

Edit in only one maximised view. This prevents all views from being updated every time you make a change.

Polygons with more than four points will be triangulated when they are rendered. Once you have finished creating your objects, triangulate them to make them slightly faster to draw.

If surfaces can only be viewed from one side, set them to single-sided. This is slightly faster to draw.

Switch on move-wireframe in both the orth and 3d menus. This temporarily sets the drawing to wireframe when being panned or zoomed using the mouse – much faster.

Keypresses

Key shortcuts for menu items are shown on the menus. Other keys can be used:

In orthographic (2D) windows:	
Key	**Function**
Cursor-keys	move view
Shift-Cursor	move view faster
Control-up	zoom in
Control-down	zoom out
Shift-Control-up	zoom in with larger step
Shift-Control-down	zoom out with larger step
Alt-Cursor	move background image
Alt-shift-cursor up/down	Scale background image

Backspace/Delete	delete current selection
Space	home windows to origin and reset zoom in each window
t	Toggle textures
o	set select mode to OBJECT
v	set select mode to VERTEX
s	Set select mode to SURFACE
m	set drag mode to MOVE
e	set drag mode to EXTRUDE
f	fit selection to window
F/control-f	fit selection to all views (Control f fits everything to all views)
G	centre window at centre of selection
H	hide selected objects
z	zoom in
x	zoom out

Some of the keys for the 3D window have equiv. menu item in the 3D menu.

In the 3D view:	
Key	**Function**
W	Wireframe/filled toggle
T	toggle textures
L	toggle headlight
G	toggle 3d grid
f	fit to window

Cursor-keys - spin model in 'spin-mode', control viewpoint in a similar way to 'quake' in walk mode e.g. left, right, forward back, alt-up/down move up/down, control-up/down tilt.

Preferences/settings

The settings in File->settings are saved automatically when you exit AC3D.

This automatic saving can be switched off (you must save the settings with this off for the change to be remembered). Some settings such as the background colours of the windows can be adjusted in the settings file but beware –

changing values that you don’t know about could cause AC3D to behave unexpectedly or crash.

Under Unix, the settings are saved to $HOME/.ac3dprefs. Under Windows, they are saved to the users home directory as ac3dprefs.txt.